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REDESCRIPTION AND NEW RECORDS OF *TRICHODIAPTOMUS CORONATUS* (G. O. SARS) (COPEPODA; CALANOIDA; DIAPTOMIDAE) FROM BRAZIL

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Abstract.—*Trichodiaptomus coronatus* (G. O. Sars), originally described from São Paulo, Brazil, has been recorded recently only from Brazilian Amazonia and the Orinoco Delta. This article reports new records from four localities in the Brazilian highlands, including the first record from the Rio São Francisco Basin. A redescription of representatives from these populations is furnished. Morphological variations reported for this species in Amazonia were not observed in the southern populations examined. *T. coronatus* inhabits clear or blackwater, extremely oligotrophic rivers, ponds and reservoirs.

G. O. Sars (1901) described a distinctive freshwater calanoid copepod, *Diaptomus coronatus,* from cultures of dried mud from the State of São Paulo, Brazil. Wright furnished additional morphological details of populations of this species from Santarém, State of Pará (1927), and the State of São Paulo (1937). Thomasson (1954, 1955) reported *Diaptomus melini* as a new, similar species from Manaus, State of Amazonas. Noting morphological variability in Amazonian populations of *D. coronatus,* Brandorff (*in* Brandorff et al. 1982) synonymized *D. melini* with Sars' species and proposed the new genus *Trichodiaptomus* for it. Although *T. coronatus* has been recorded several other times from Brazilian Amazonia (Andrade & Brandorff 1975, Brandorff 1972, Cipólli & Carvalho 1973, Matsumura-Tundisi 1986) and once from the Orinoco Delta, Venezuela (Dussart 1984), it has not been encountered again in southeastern Brazil. This article reports new records from the Distrito Federal, Goiás, and Minas Gerais in the central Brazilian highlands, including the first record from the Rio São Francisco Basin; redescribes the species; and summarizes knowledge of its ecological requirements.

Genus *Trichodiaptomus* Brandorff (*in* Brandorff et al., 1982)
Trichodiaptomus coronatus (G. O. Sars, 1901)
Figs. 1–21

Diaptomus coronatus G. O. Sars, 1901:14–16, pl. III, figs. 9–17.—Daday, 1905: 151.—Tollinger, 1911:66, fig. A2.—Pesta, 1927:80.—Wright, 1927:74, 75, 90–91, 100, pl. VI, figs. 7–9; 1937:66, 77–79, pl. III, figs. 5–8; 1938:562.—Brandorff, 1972:8, 9, 20–23, 50, figs. 19–22.—Cipólli & Carvalho, 1973:95, 97, 98, 100, 101, 108.

"*Diaptomus*" *coronatus* G. O. Sars.—Andrade & Brandorff, 1975:97, 103.—Brandorff, 1976:618, 619, 622, fig. 3; 1978: 1201.

Diaptomus melini Thomasson, 1954:193–194, fig. III 1 a–c; 1955:214.—Brandorff, 1972:20–21, 48.

"*Diaptomus*" *melini* Thomasson.—Andrade & Brandorff, 1975:102.

Trichodiaptomus coronatus (G. O. Sars).—Brandorff et al., 1982:76, 104–106, figs. 104–110.—Dussart & Defaye, 1983: 134.—Arcifa, 1984:143.—Dussart, 1985: 201.—Reid, 1985:78–79, fig. 1.—Mat-

sumura-Tundisi, 1986:547, 551, figs. 89–94, 100.

Notodiaptomus coronatus (G. O. Sars).—Dussart & Defaye, 1983:134.—Dussart, 1984:34, 39.

Rhacodiaptomus Melini (Thomasson).—Brehm, 1965:15.

Rhacodiaptomus Mileni (Thomasson).—Brehm, 1965:15.

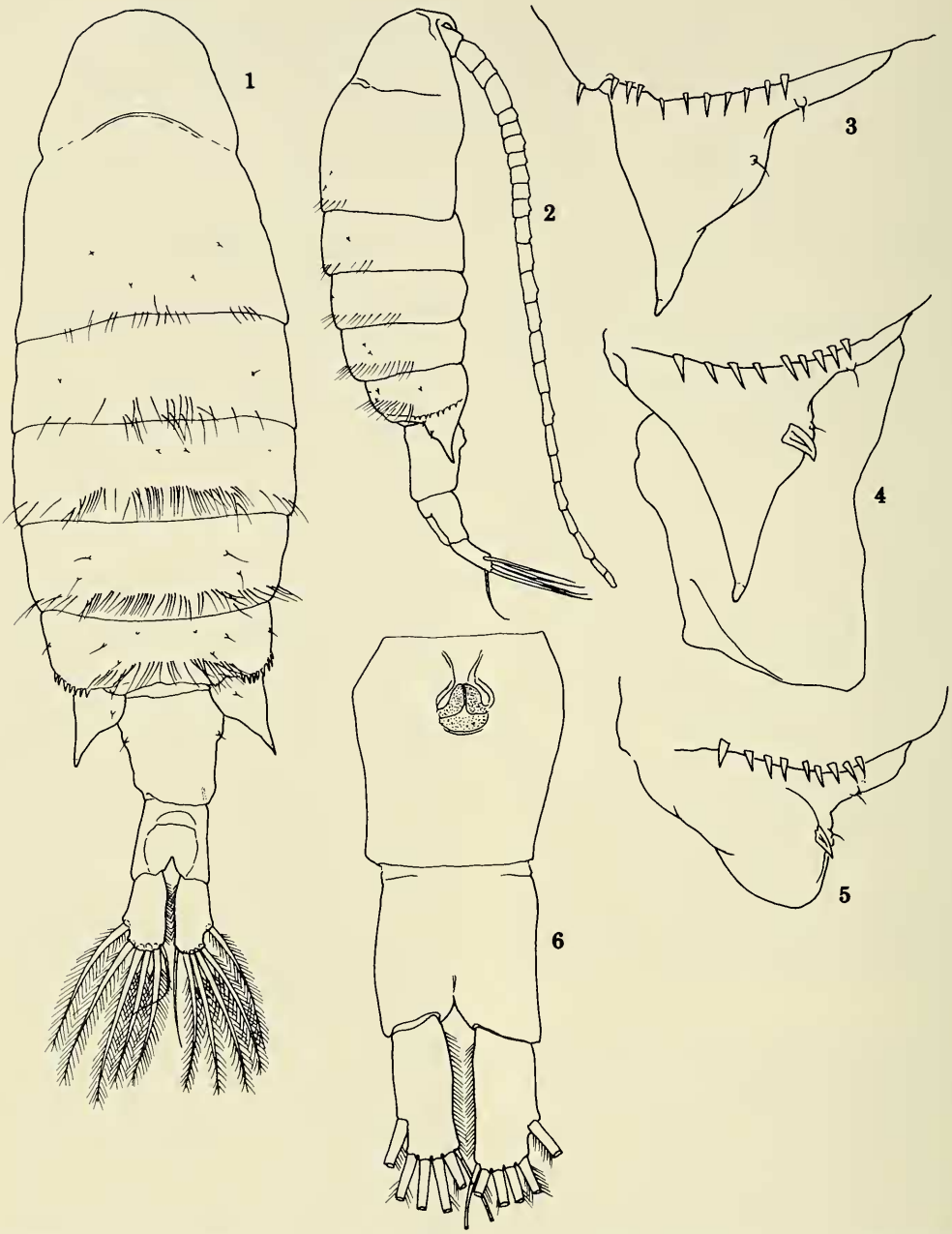
Material.—Brazil: 1 ♂ and 1 ♀, Santarém, Pará (undated), USNM 58920, 58921, col. S. Wright. 100+ adults, Lagoa Bonita (Lagoa Mestre d'Armas), Distrito Federal, 15°34′S, 47°10′W, 19 Jan 1979, 24 Jan 1979, 9 Sep 1980, 23 Sep 1980, 21 Oct 1980, 4 Nov 1980; 15 adults, Lagoa Formosa, Goiás, 15°30′S, 47°36′W, 26 Oct 1980, 4 Jul 1982; 100+ adults, Represa (Rep.) Santo Antônio do Descoberto, Distrito Federal/Goiás, 15°44′S, 48°10′W, 25 Oct 1980, 8 May 1982, all USNM 241951; 200+ adults, Lagoa Bonita, 23 Sep 1980, Museu de Zoologia da Universidade de São Paulo (MZUSP) 9651; 200+ adults, Lagoa Bonita, 9 Sep 1980, MZUSP 9652; 200+ adults, Rep. Santo Antônio do Descoberto, 8 May 1982, MZUSP 9653; 16 adults, Lagoa Formosa, 4 Jul 1982, MZUSP 9654; col. J. W. Reid and/or L. El-Moor Loureiro. 12 ♀, Lagoas Tacho, Paiano, and Cipó (combined samples), Pirapora, Minas Gerais, 17°20′55″S, 44°57′00″W, 1988; M. B. G. e S. Dabés collection.

Female.—Median lengths (and ranges), excluding caudal setae, of specimens from Lagoa Bonita 1.13 mm (1.05–1.28 mm; n = 40); from Rep. Descoberto 1.20 mm (1.12–1.28 mm; n = 14); from Lagoa Formosa 1.20 mm (1.08–1.30 mm; n = 18); from Pirapora ponds 1.28 mm (1.22–1.35 mm; n = 12). Body widest at pedigers 1–2 in dorsal view (Fig. 1). Pedigers 4 and 5 (Figs. 1–3) separated; pediger 5 produced on each side into posteriorly directed, pointed wing reaching past midlength of genital segment. Few females with one wing bearing large dorsally directed spine, wing sometimes also not fully pointed (Figs. 4, 5); opposite wing always normally pointed. Prosomites with 1–5 pairs of papillae each tipped with fine hair, and rows of hairs near posterior margins, hairs on pedigers 2–4 coarser. Pediger 4 (Figs. 1–5) with lateral row of 5–13 large spines, usually a similar number on each side. Urosome (Figs. 1, 2, 6) of 2 segments; anterior portion of genital segment slightly expanded laterally; lateral sensillae on genital segment similar to prosomal ones. Genital field as in Fig. 6. Inner margins of caudal rami hairy.

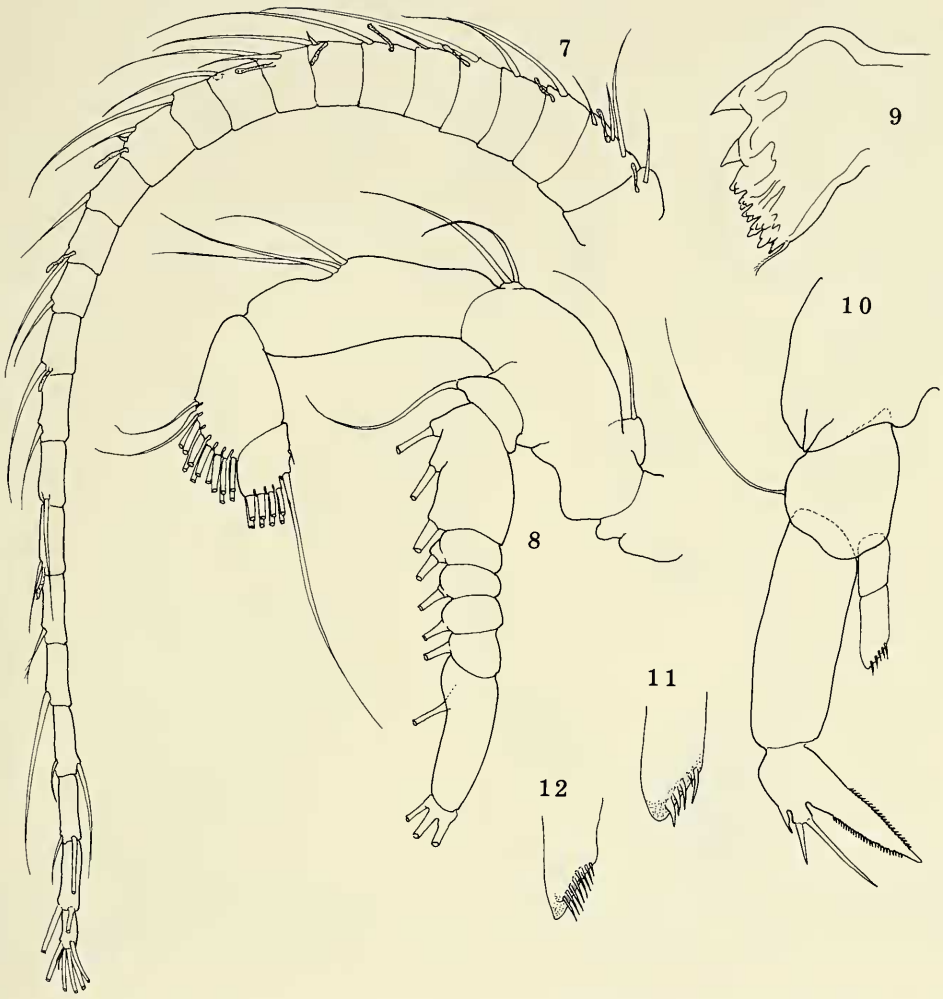
Rostral points acute. Antennule (Figs. 2, 7) reaching past end of caudal rami; armament similar to that of *Scolodiaptomus corderoi* (Wright) as redescribed by Reid (1987), particularly in having only 1 seta on article 11. Antenna (Fig. 8) with 2–3 setae on anterior margin of endopod 1, posterior margin of this article lacking ornament; antenna otherwise normal for family. Gnathal lobe of mandible (Fig. 9) with acute apical and subapical teeth, dentition otherwise similar to that of *S. corderoi*. Remaining mouthparts and legs 1–4 also similar to those of *S. corderoi* and typically diaptomid; Schmeil's organ present on posterior surface of leg 2 endopod article 2.

Leg 5 (Figs. 10–12) slender; exopod article 3 continuous with article 2. Endopod of 2 distinct articles, reaching slightly beyond midlength of exopod article 1; endopod 2 with subterminal oblique row of 5–8 spinules.

Male.—Median lengths of specimens from Lagoa Bonita 0.85 mm (range 0.82–1.00 mm; n = 24); Rep. Descoberto 0.90 mm (0.72–0.95 mm; n = 20); Lagoa Formosa 0.90 mm (0.88–1.06 mm; n = 3). Habitus (Fig. 13) as in female, except urosome 5-segmented, pediger 4 with 4–8 spines on each side, wings of pediger 5 short. Left antennule, mouthparts, and legs 1–4 as in female. Right antennule (Figs. 14–16) with articulated spines on articles 8 and 12; spine on article 11 longer than spine on article 10; spine on article 13 equal to or longer than



Figs. 1–6. *Trichodiaptomus coronatus,* females (1 and 2 from Pirapora ponds; 3–6 from Lagoa Bonita): 1, Habitus, dorsal; 2, Habitus, right lateral; 3, Pedigers 4-5 of normal specimen; 4, Pedigers 4–5 and genital segment of specimen with abnormal spine on left wing; 5, Pedigers 4–5 of specimen with abnormal spine on rounded left wing; 6, Urosome and caudal rami, ventral.

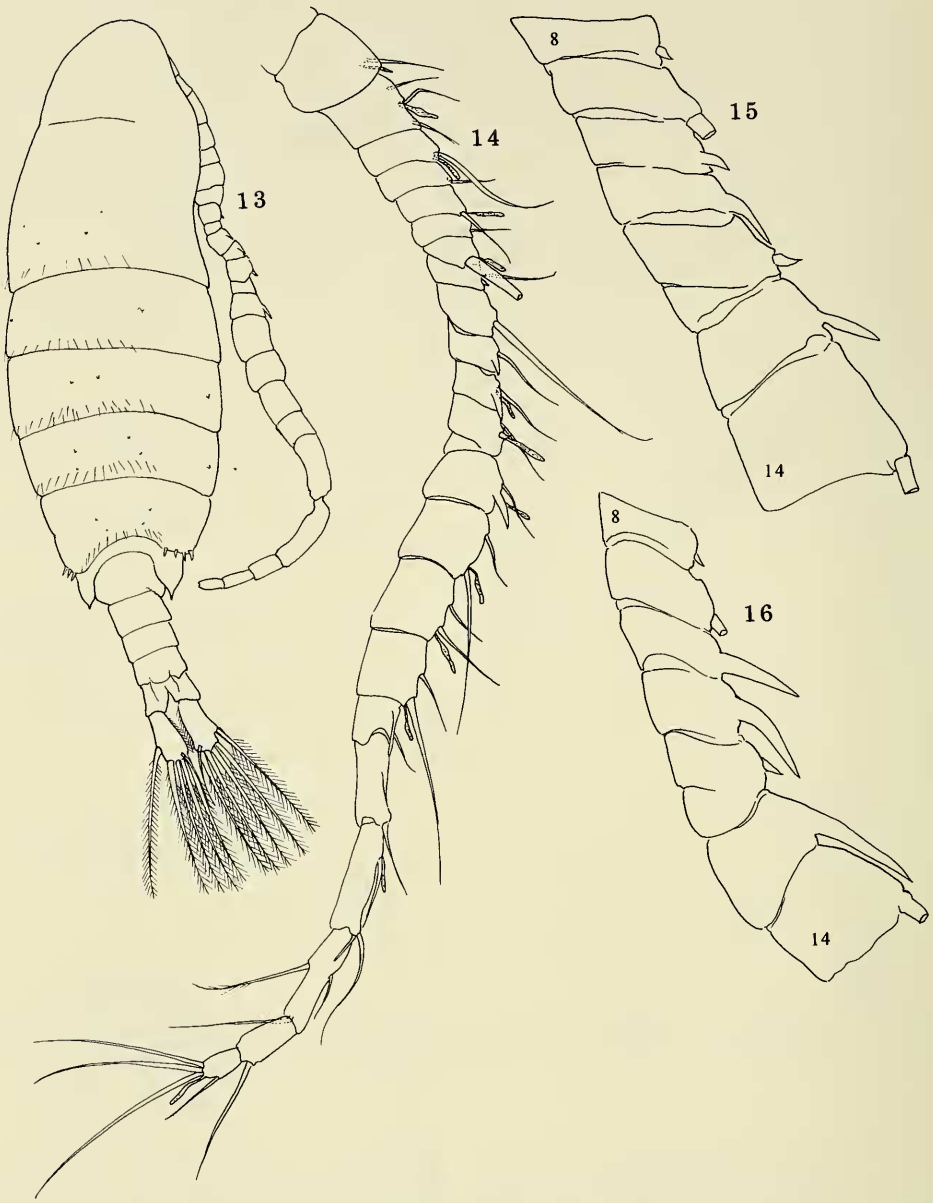


Figs. 7–12. *Trichodiaptomus coronatus,* females from Lagoa Bonita: 7, Antennule; 8, Antenna; 9, Gnathal lobe of mandible; 10, Leg 5; 11 and 12, Detail of end of leg 5 endopod 2 from different specimens.

spine on article 11. Spines on articles 10, 11, and 13 more developed in specimen from Amazonia (Fig. 16). Articles 14–16 without spines. Antepenultimate article without distal process.

Left leg 5 (Figs. 17–21) slender; posterior mammiform process on basipod 1 small, ending in short spine. Margins of basipod 2 nearly straight. Endopod of 2 indistinctly separated articles, distal article with few hairs near conical tip. Exopod of 2 articles, each with hairy pad on anteromedial surface, proximal pad slightly developed. Article 2 rotated inward, bearing acute, finely pectinate digital process, and slender spine with fine hairs.

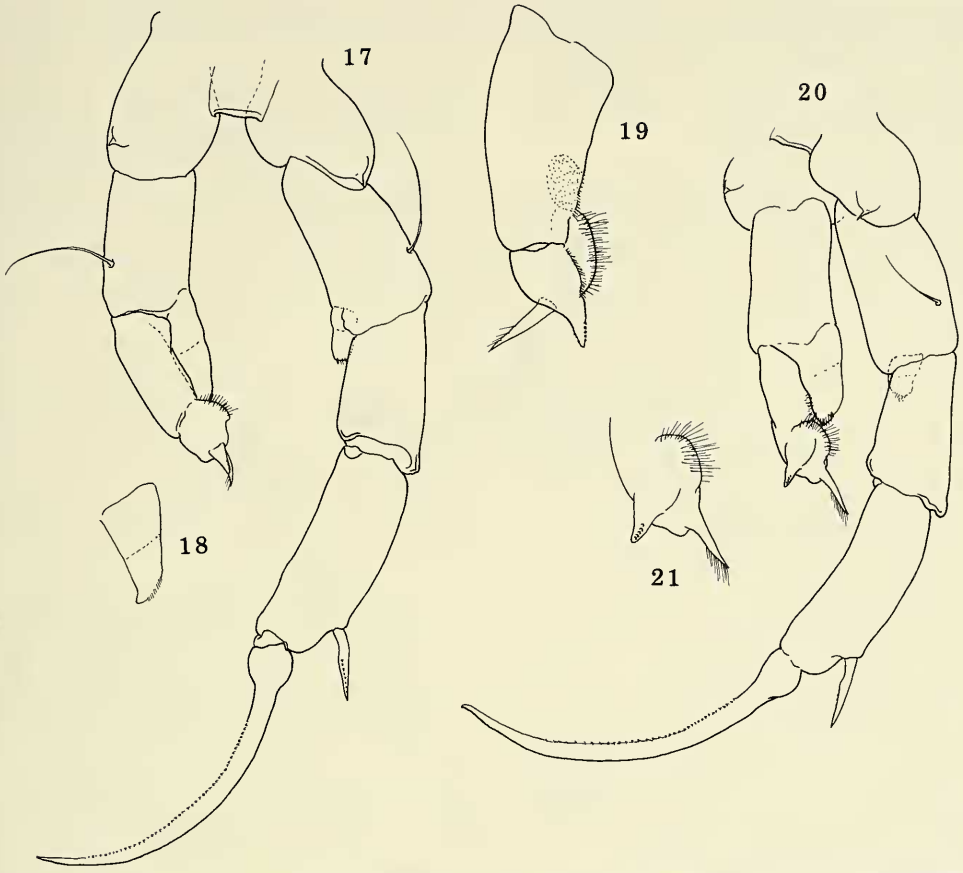
Right leg 5 (Figs. 17, 20), with basipods 1 and 2 similar to basipod of left leg; endopod of 2 indistinctly separated articles, oblique terminal surface hairy. Exopod 1 with inner and outer distal corners slightly extended. Exopod 2, lateral spine shorter



Figs. 13–16. *Trichodiaptomus coronatus,* males (13–15 from Lagoa Bonita; 16 from Santarém): 13, Habitus, dorsal; 14, Right antennule; 15 and 16, Articles 8–14 of right antennule (most setae and esthetascs not indicated).

than breadth of exopod; terminal claw equal in length to exopod, tip of claw slightly recurved in some specimens.

Variation. —Lengths of females from southern Brazil are less than lengths (1.19–1.46 mm) reported by Brandorff et al. (1982) for Amazonian populations. Wright (1937) gave the length of the female as 1.28 mm and of the male as 0.97 mm; Sars (1901) as 1.30 mm for females. The southern popu-



Figs. 17–21. *Trichodiaptomus coronatus,* males (17, 18, 20, 21 from Lagoa Bonita; 19 from Represa Descoberto): 17, Leg 5, posterior; 18, Detail of left endopod, posterior; 19, Detail of left exopod, posterior (stippling indicates area of proximal hairy pad); 20, Leg 5, right-lateral; 21, Left exopod 2, medial.

lations did not include individuals with short thoracic wings and/or prominences on the left side of the genital segment, originally named *D. melini* by Thomasson (1954) and termed "Females II–IV" by Brandorff (Brandorff et al. 1982). All southern females observed, both by Wright (1937) and in the present study, correspond to Brandorff's "Female I," with symmetrical genital segment and long, posteriorly directed, pointed wings; except for the few anomalous individuals noted here.

Brandorff *in* Brandorff et al. (1982) noted that Type I females tended to have more lateral spines on pediger 4 than did other morphs. Among the southern populations, females from Lagoa Formosa had significantly ($P \leq 0.01$; $t = 5.5$, $df = 114$) fewer spines on each side (4–10, mean 7.1) than females from Lagoa Bonita (6–13, mean 8.8). Lagoa Formosa females also had fewer, although not significantly fewer spines than females from Rep. Descoberto (7–11, mean 8.6) and Pirapora (9–11, mean 9.3). These latter three populations did not differ significantly among themselves in spine number. Males from the three populations examined (Bonita, Descoberto, Formosa) did not differ significantly in spine number, having 4–8 spines on each side. In both sexes,

spine number tended to be about equal on each side, differing by no more than 4. On females from São Paulo, Sars (1901) observed "about 12 denticles," while Wright (1937) noted 8–12 spines.

Matsumura-Tundisi (1986, Amazon) figured the antennule of the female as reaching only to midlength of the genital segment; Wright (1927, Amazon) and Sars (1901, São Paulo) to midlength of the anal somite.

Brandorff (1972), Matsumura-Tundisi (1986), and Wright (1927) figured the exopod 3 of leg 5 of the female as distinct from exopod 2. Matsumura-Tundisi (1986) and Thomasson (1954) figured the endopod of leg 5 of the female as a single article. These are probably lapses of observation.

It appears that the unarticulated spines on articles 10, 11, and 13 of the right antennule of males are more prominently developed in Amazonian populations. Wright (1937:78) mentioned differences "particularly in the spination of the right antenna of the male" between São Paulo and Amazonian specimens. His figure of a male from São Paulo (op cit.: pl. III, fig. 6) shows relatively short spines on articles 10, 11 and 13, similar to those from the southern highlands (Fig. 15). Sars (1901: pl. III, fig. 15) also figured a short spine on article 13. Although Wright did not figure these spines from Amazonian males, he mentioned (1927:90) that the process of "the fifteenth segment" (probably article 13, since more distal articles have no processes) extends well past the middle of the succeeding article, similar to the structure of the male from Santarém deposited at NMNH (Fig. 16). Figures of Amazonian specimens by Brandorff (1972) and Matsumura-Tundisi (1986) also show long unarticulated spines similar to Fig. 16.

Distribution and ecology.—Brandorff (1976) noted the broad distribution of *T. coronatus* from the Brazilian Amazon to São Paulo State, a range further enlarged northwards by Dussart's (1984) record from the Orinoco Delta (Fig. 22). In spite of this unusual latitudinal distribution, *T. coronatus* seems to be a species of narrow habitat requirements (Table 1). Although it has been found in both lentic and lotic waters, available habitat data clearly indicate that it is restricted to warm, acid waters of low conductivity and extreme oligotrophy. Thus it has been most frequently collected from, but is not limited to Amazonian "black" waters (high in humic acids). Most of the localities, particularly in Amazonia, have been shallow streams and floodplain (várzea) lakes; similarly, Lagoas Bonita and Formosa are small, shallow ponds less than 10 ha in area, with extensive macrophyte beds. The ponds at Pirapora are also shallow, with much macrophyte coverage (M. B. G. e S. Dabés, pers. comm.). Santo Antônio do Descoberto and Guarapiranga seem to be unusual habitats for this species, being large reservoirs; at least the former, in which *T. coronatus* was the only diaptomid species at the time of collection, has no significant macrophytes. Possibly *T. coronatus* is a more littoral than pelagic species, particularly when in competition with other diaptomids.

Occurring only in Guarapiranga Reservoir out of 41 water bodies examined in eastern São Paulo in 1935 (Wright 1937), the species appears to have disappeared from Guarapiranga and has been recorded recently from none of the now mainly eutrophic reservoirs in that state (Sendacz et al. 1985). São Paulo reservoirs are now characterized by, among other species, *Scolodiaptomus corderoi* and *Thermocyclops decipiens* (Kiefer), which are typical inhabitants of highly productive systems (Reid 1987, 1988, 1989; Sendacz et al. 1985). Of numerous water bodies examined in the central Brazilian highlands, those in which *T. coronatus* is present include several of the most oligotrophic but none of the more productive systems. Therefore, it seems to be a useful indicator species, and

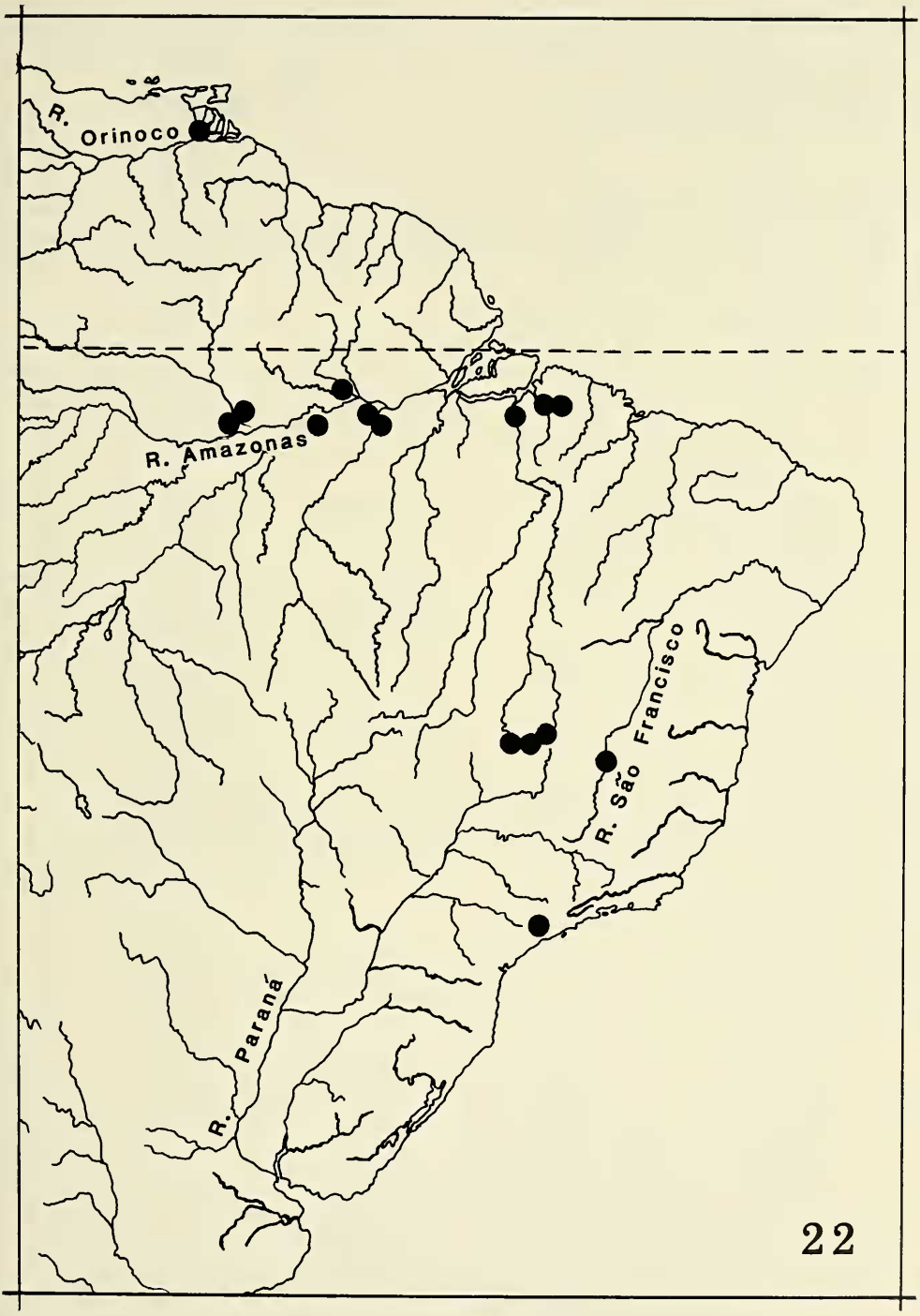


Fig. 22. Records of *Trichodiaptomus coronatus* (G. O. Sars) in eastern South America.

Table 1.—Environmental parameters recorded for collections of *Trichodiaptomus coronatus* (Sars).

Locality (Reference)[a]	Water body	Depth (m)	T (°C)	pH	Cond. (μS)	Color	Bottom
SP[b] (1)	—	—	—	—	—	—	mud
Santarém, PA (2)	bayou	—	—	—	—	—	—
Rep. Guarapiranga, SP (3)	reservoir	—	—	—	—	—	—
Rio Negro, Manaus, AM (4)	lagoon	—	28	—	—	—	—
Lago Jurucuí, PA (5)	lake	3.1	28.9	5.5	—	yellow	—
Rio Apocoitana, AM (5)	river	1.5	30.0	4.8	—	clear/green	—
Igarapé Jari, Ariacana, Rios Guamá/Capim, PA (6)	stream	—	—	5	—	black	—
Lago Timbiras, Caranandeua, PA (6)	flooded area	—	—	—	—	—	—
Igarapé S. Lourencinho, Rio Tocantins, PA (6)	stream	—	—	5	—	black	—
Tarumã-Mirim, Rio Negro, AM (7)	river	—	—	5.0[c]	9[c]	black	—
Lago da Terra Santa, Rio Nhamundá, AM/PA (8)	várzea lake	5.5	—	5.6	16	black	—
Terra Santa Village, AM/PA (8)	flooded meadow	1.4	—	5.4	12	black	—
Rio Xuedá, AM/PA (8)	igapó	—	—	5.2	9.5	black	—
Rio Nhamundá, AM/PA (8)	flooded meadow	—	—	5.0	9	black	sand
Caño Guara, Orinoco Delta, Venezuela (9)	stream	—	—	—	—	—	—
Lago Cristalino, AM (10)	lake	—	—	"low"	3–8	black	—
Rep. Santo Antônio do Descoberto, GO/DF (11)	reservoir	10	17.2	—	10	turbid	clay
Lagoa Bonita, DF (11)	pond	2	—	6.5	10	clear	organic
Lagoa Formosa, GO (11)	pond	2	25	—	10	clear	sand/clay
Lagoas Tacho, Paiano, Cipó, Pirapora, MG (11)	floodplain ponds	shallow	28	6.0	—	—	organic

[a] 1, Sars (1901); 2, Wright (1927); 3, Wright (1937); 4, Thomasson (1954, 1955); 5, Brandorff (1972); 6, Cipólli & Carvalho (1973); 7, Brandorff (1978); 8, Brandorff et al. (1982); 9, Dussart (1984); 10, Matsumura-Tundisi (1986); 11, present report (environmental data for Pirapora ponds supplied by M. B. G. e S. Dabés).

[b] Brazilian state abbreviations: AM, Amazonas; DF, Distrito Federal; GO, Goiás; MG, Minas Gerais; PA, Pará; SP, São Paulo.

[c] Means from Furch (1984).

its biological requirements merit further investigation.

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